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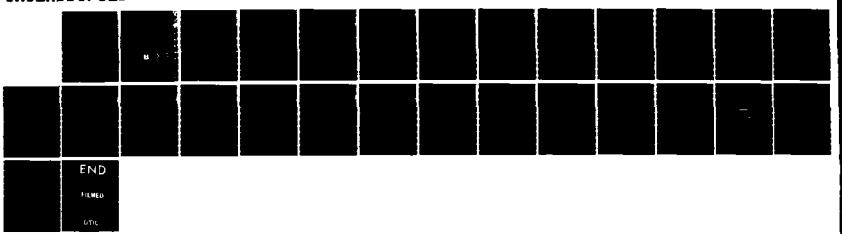

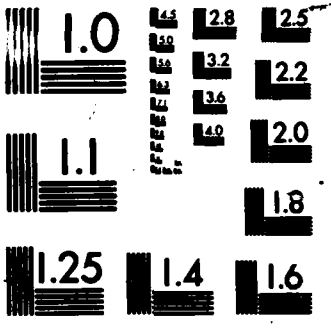

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AN OVERVIEW OF THE TRAINING AND PERFORMANCE SUPPORT SYSTEM

By

MARY L. URBAN

DECEMBER 1985

Prepared for

DEPUTY FOR ACQUISITION LOGISTICS AND TECHNICAL OPERATIONS
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
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The Training and Performance Support System (TPSS) was developed as a method of providing training and as an on-the-job support tool for Air Force personnel who are assigned to System Program Offices and involved in the acquisition of mission critical computer resources. The system is based on a three-level instructional concept that integrates training into an operational environment. The computer-based training provides modularized instruction that can be tailored to individual needs based on the student's background, job requirements, and daily schedule. The prototype application of the concept is for teaching Software Acquisition management.

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Program Element 64740F is the Air Force engineering development program to develop and employ technology, tools, and techniques essential to managing the growth in Air Force systems that use computer resources. The program's goals are to: provide for the transition of computer system developments in laboratories, industry, and academia to Air Force systems; develop and apply software acquisition management techniques to reduce life cycle costs; provide improved software design tools; address the various problems associated with computer security; develop advanced software engineering tools, techniques, and systems; support implementation of high order languages such as Ada; address human engineering for computer systems; and develop and apply computer simulation techniques for the acquisition process.

The Computer Systems Engineering and Applications Project (5720) is the ESD initiated effort to improve the acquisition of mission critical computer resource software. The goals of the project are to: provide guidance, tools, systems, and techniques to Program Offices (including the transitioning of products from Program Element 64740F); interact with Air Force and DOD organizations that establish policies, regulations, and standards for software acquisitons; and direct associated tehnology efforts.

The author acknowledges the contributions of Dona G. Eaton, Richard F. Hilliard, and Alice M. Mulvehill. Much of the content of this overview is derived from working papers written by them in support of the TPSS project. Lt. Akiko Sudano, ESD/ALSE, the TPSS Project Officer, provided many helpful comments and suggestions.

TABLE OF CONTENTS

Section		Page
	LIST OF ILLUSTRATIONS	vi
	LIST OF TABLES	vi
1	INTRODUCTION	1
2	INSTRUCTIONAL CONCEPT	3
3	THE TPSS PROTOTYPE APPLICATION	5
	EDUCATION LEVEL	5
	JOB ENTRY LEVEL	7
	PERFORMANCE SUPPORT	10
4	PROTOTYPE SYSTEM DESCRIPTION	15
	SYSTEM HARDWARE	15
	SYSTEM SOFTWARE	16
	USER INTERFACES	19
5	CONCLUSION	21

LIST OF ILLUSTRATIONS

Figure		Page
1	The TPSS Instructional Concept	3
2	Structure of Job Entry Level CAI Lessons	10
3	Performance Support Matrix	12
4	Curriculum Content	13
5	TPSS Prototype Hardware	15
6	Instructional Software	18
7	Authoring Software	19
8	User/System Interfaces	20

LIST OF TABLES

Table		Page
1	Embedded Computer Software Quality Management Curriculum	6
2	Job Entry Level CAI Lesson Titles	9
3	Performance Support Databases	11

SECTION 1

INTRODUCTION

The Training and Performance Support System (TPSS) is a computer-based training system based on a three-level instructional concept that integrates training and on-the-job support into an operational environment. TPSS provides modularized instruction that can be tailored to individual student needs based on background, job requirements, and daily schedule. The prototype application is for Air Force personnel assigned to System Program Offices (SPOs) and involved in the acquisition of computer resources for mission critical systems. TPSS is a method of providing trained computer resource personnel to the SPOs on a timely basis, and increasing the immediate usefulness of novice computer resource personnel.

As a system, TPSS consists of hardware, software, instructional materials, personnel, procedures, communications, and facilities. The hardware and software provide the technology for development and delivery of courseware in a training facility, and the development and availability of relevant information for the work environment. Courseware for the prototype application has been developed for a specific curriculum, Software Acquisition Management. The technology is readily usable for other courseware in areas where training requirements are unique, recurrent, and not being satisfied.

The initial development effort for TPSS is scheduled for completion September 30, 1984. At that time, a training capability, employing a prototype system, will be operational at Hanscom AFB, MA.

The TPSS project is sponsored by the Computer Engineering Applications Division (ALSE), Deputy for Acquisition Logistics and Technical Operations, Air Force System Command Electronic Systems Division (ESD). Funding for this effort was provided by the Air Force Computer Resource Management Technology Program. This Program Element, PE 64740F, is the Air Force engineering development program which develops and transfers into active use computer resource technology, tools, and techniques. The development contractor is Denver Research Institute (DRI), a non-profit research center of the University of Denver. The MITRE Corporation provides technical support to ESD/ALSE in the acceptance, installation, test, and evaluation of the prototype TPSS, and the start up of the system at ESD.

SECTION 2

INSTRUCTIONAL CONCEPT

Air Force personnel assigned to work on electronic system acquisition differ in their needs for information on specific topics, their background level of experience, preferred style of learning and access to scheduled training. TPSS can, in part, provide individualized education in response to these needs.

TPSS differs from traditional approaches to training in that it integrates the instructional process with post-training needs for support to the students once they are in the job environment.

The instructional concept of TPSS consists of providing training at three distinct levels as shown in figure 1.

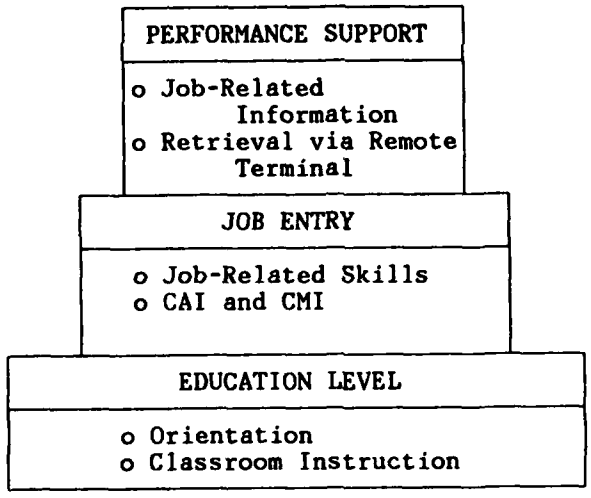

Figure 1. The TPSS Instructional Concept

The Education level provides an orientation to the nature of the total job and an introduction to the broad subject area. The Job Entry level provides modularized, in-depth instruction on particular topics oriented to an individual's specific work assignment. Performance Support provides job aids that are accessed by individuals in the work environment. It complements the Job Entry instruction and provides detailed information during the performance of a specific job activity as needed. Each level presents information in increasing detail and focus, and builds on information presented at the previous level. TPSS is designed so that students at the detailed levels (Job Entry and Performance Support) can tailor the curriculum to stress instruction in topics required for their jobs.

Training is delivered using several different media including classroom lectures, computer-aided instruction (CAI), and computer-aided video instruction (CAVI). The Education level can be implemented with either traditional classroom instruction or computer-based instruction. Job Entry, because of its inherent requirements to provide individualized instruction and practice, is implemented with CAI. To provide a remote, on-the-job access to Performance Support, digital communication is required. The approach, method of presentation, and instructional content of the three levels used in the prototype application of this concept are discussed in section 3 of this paper. The computer-based system developed to support any application of the TPSS concept is described in section 4.

SECTION 3

THE TPSS PROTOTYPE APPLICATION

When new computer resource (CR) personnel arrive at ESD they are assigned to a SPO where they will be involved in a phase of the electronic system acquisition cycle. The objective of the TPSS prototype course is to make these personnel knowledgeable in the areas of system planning, software technology, contract management, and the procedures for software acquisition as governed by the AFR 800 series of regulations. Its initial offering is at ESD; the target training population extends to the Computer Technology Career Area (Specialties 5111 to 5155) of the Air Force.

Education Level

Shortly after arrival at ESD, novice CR personnel are enrolled in the Education level of TPSS via the computer-managed instruction (CMI) capability of the system. Student records, containing general registration information, are created and maintained, allowing each student's progress to be tracked through the curriculum.

At the Education level, the fundamentals of system acquisition technology and system acquisition management are presented in a five-day intensive orientation. An instructor delivers lectures in a traditional classroom format to a group of students. In addition, the instructor can supplement the lectures with lesson modules of relevant CAVI.

The first lecture at the Education level introduces TPSS to the students so they will know how they are expected to proceed through the three levels of instruction. Model Acquisition Example materials are given to students in notebook form and include a System Specification, Part I or "B" and Part II or "C" Specifications for one Computer Program Configuration Item (CPCI), a Computer Program Development Plan (CPDP), and System and CPCI Test Plans. (See table 1)

Subsequent lecture topics are designed to establish a software quality management theme for the course. These lectures attempt to place the software acquisition process in perspective relative to the overall system acquisition process and to introduce the tools and techniques of software quality management. The lectures describe the process of software development and the system of directives, regulations, and standards that govern and constrain the management of that process. Students are given an overview of how software specification, design, development, test, evaluation, and documentation are accomplished as part of an acquisition contract.

Table 1

Education Level Curriculum --
Embedded Computer Software Quality Management

Lecture Topics

1. Introduction
2. Approaching the Problem
3. System Acquisition Process
4. Software Acquisition
5. System Planning
6. Software Planning
7. Planning for Software Maintenance
8. Software Development
9. System Software Documentation
10. Monitoring Software Development
11. Contractor Software Quality Assurance Requirements
12. Software Quality Assurance Plan
13. Software Configuration Management
14. Reviews and Audits
15. Test and Evaluation
16. Software Testing Criteria
17. Request for Proposal (RFP) and Software Procurement Package
18. Statement of Work, Contract Data Requirements List, Data Item Descriptions
19. Proposal Evaluation
20. Evaluating Cost and Schedule Estimates
21. Turnover and Transfer
22. Review and Critique

Model Example Materials

1. Segment A System Specification
2. Part I Specification (B-5), Data Reduction and Analysis CPCI
3. Part II Specification (C-5), Data Reduction and Analysis CPCI
4. Computer Program Development Plan (CPDP), Segment A
5. Segment A System Test Plan
6. Data Reduction and Analysis CPCI#2 Qualification Test Plan (Version 2)
7. Data Verification Executive CPC#2 Test Plan (Version 3)

The "Model Example" is introduced and referenced in classroom discussions to establish a familiar framework within which task performance can be elaborated, problems presented, and solutions explored. This example counterbalances the high degree of abstraction normally encountered in references to system acquisition, system project management, life cycle events, and the like. It provides a means for demonstrating system complexity and illustrating the application of management principles and policies in the acquisition of a major system. For these same reasons the Model Example is also referenced in the Job Entry level of instruction. The Model Example deals with the acquisition of a so-called "Hypothetical System," which will add new satellites, sensors, and processing facilities to an existing satellite and ground-based intelligence gathering, and analysis capability. The Model Example does not provide a full view of a hypothetical system; but rather selectively presents certain aspects of the system while ignoring others. It attempts to provide a representative "slice" through the entire system acquisition process and the relevant associated documentation.

Lesson plans for lectures, collectively known as the Embedded Computer Software Quality Management (ECSQM) course, are available to assist an instructor in presenting this overview course. The lecture topics are listed in table 1. Each lesson plan describes the lesson objectives and topics to be covered. The instructional materials include a lecture outline, sequence of viewgraphs, and relevant background material for each topic.

Job Entry Level

After completing the Education level, students enter into the Job Entry level of instruction. At this level, the TPSS prototype training facility provides CAI lessons consisting of detailed instruction on Software Acquisition Management topics introduced at the Education level. These CAI lessons form the major portion of the TPSS courseware. Training at the Job Entry level is accomplished with modular instruction, tailored for the individual. All or some portion of the total curriculum of CAI lessons will be assigned (or prescribed) to each student based on the particular phase of the acquisition cycle for which the student will be responsible. As these responsibilities change, the student can receive instruction in topics relevant to other phases. For example, if the student's SPO will be involved in development testing, the student will be assigned Job Entry lessons on testing. When development testing is complete and the SPO is preparing to transfer the system to the user, the student can return to the training facility and receive CAI lessons on system turnover and transfer.

Job Entry instruction trains novice CRs to perform tasks while working with others as a team. For purposes of instruction, the student role projected is lead software engineer in a SPO. Tasks attributed to CR personnel were defined by analyzing activities requiring allocation of professional time and effort in the SPO. The Job Entry lessons offer "how-to" information and warnings on unanticipated problems and pitfalls normally associated with software engineering. These lessons also explain major technical issues that can impact the outcome of an acquisition, and the knowledge, skills and abilities needed by the SPO lead software engineer.

The TPSS Job Entry lessons on Software Acquisition Management are divided among the following five major topics:

1. General Management
2. Contract Planning
3. Product Development
4. Reviews and Audits
5. Test and Evaluation

The titles of the Job Entry lessons assigned to each major topic are listed in table 2.

Some of the lessons are segmented to present a System Perspective, followed by a description of Planning, Organizing, Controlling, and Communicating, activities relevant to milestones and associated events. This structure is derived from fundamental management functions and assists in describing the management role that the student will encounter during an acquisition event. The structure of the topics, lessons and lesson segments is illustrated in figure 2. The System Perspective gives a view from the past and present and toward the future. In Planning, the student considers actions, events, and milestones that must precede the designated current event. The Organizing segment examines activities relating to government and contractor preparations, completion of these activities, and review of documentation. The fourth segment presents ideas for Controlling and evaluating the technical status and adequacy of the work leading up to the event and the adequacy of the contractor's management so far. Finally, the responsibility of the software engineer for Communicating to close out the event is identified. This segmenting by engineering management function is the basis for the matrix structure employed within Performance Support that supplies the student with a "map" to available information.

Table 2

Job Entry Level CAI Lesson Titles

1. Introduction to Management, Planning, Coordination
2. Computer Resources Integrated Support Plan/Transfer and Turnover/Working Groups
3. Configuration Management
4. Software Quality Assurance
5. Introduction to Contract Planning
6. Request for Proposal
7. Source Selection
8. Introduction to Engineering Documents
9. A Specification
10. B Specification
11. C Specification
12. Computer Program Development Plan
13. Introduction to Reviews and Audits
14. * System Requirements Review
15. * System Design Review
16. * Preliminary Design Review
17. * Critical Design Review
18. * Functional Configuration Audit/Formal Qualification Review
19. * Physical Configuration Audit
20. Introduction to Test and Evaluation
21. * Preliminary Qualification Test
22. * Formal Qualification Test
23. * System Test

* These lessons have the segment structure shown in figure 2.

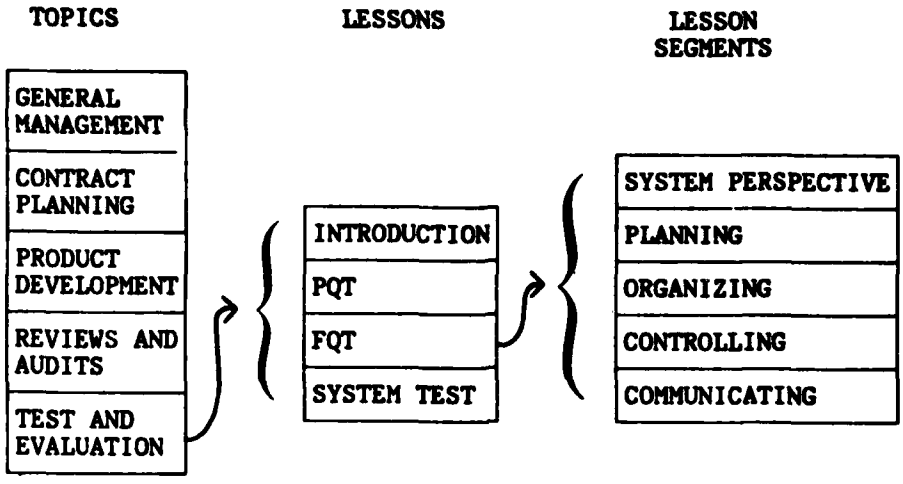

Figure 2. Structure of Job Entry Level CAI Lessons

Job Entry lessons and lesson segments are presented in three types of modules. Module I contains explanatory information which the student must understand before application in Modules II and III. In Module II, the student considers problem episodes which apply information presented in Module I and offer the student the opportunity for "self-evaluation" of learning progress. Module III consists of problems designed to determine if the student has mastered the objectives of Modules I and II.

Performance Support

After completing the prescribed Job Entry CAI lessons, students move to the work environment. During the daily job activities, they will generate specific job-related questions on policies and procedures. Through TPSS Performance Support they can reference and review authoritative information via a communication link from a terminal near (or, ideally in) their offices. The management activities described in the Education and Job Entry levels of instruction rely on directives, regulations, standards, and

Table 3

Performance Support Databases

1. Configuration Management
2. Software Quality Assurance
3. A Specification
4. B Specification
5. C Specification
6. Computer Program Development Plan
7. System Requirements Review
8. System Design Review
9. Preliminary Design Review
10. Critical Design Review
11. Functional Configuration Audit/Formal Qualification Review
12. Physical Configuration Audit
13. Preliminary Qualification Test
14. Formal Qualification Test
15. System Test
16. Glossary

specifications that guide the acquisition process. The Performance Support databases provide on-line access to a repository of this type of information which is helpful in analyzing problems and determining acceptable solutions. These databases are structured to correspond to Job Entry CAI lessons. Information includes checklists, lessons learned, summaries of Job Entry Module I information, and general considerations and policy affecting software acquisition management procedures. The information is organized by the same functional management breakout as the Job Entry lessons. Table 3 lists the prototype Performance Support databases. The information is structured and formatted so that topics are easily identified and accessed using menu-driven matrix selection routines. An example of the Performance Support matrix is illustrated in figure 3. At the left are the fundamental management functions. The columns identify types of information which can be accessed. A glossary defining software and acquisition terms and acronyms is also available through Performance Support. SPO personnel can use existing data and word processing terminals with communication capability to access Performance Support. The prototype TPSS will support eight remote terminal users simultaneously.

SYSTEM VIEW	A1	B1	C1	D1
PLANNING	A2	B2	C2	D2
ORGANIZING	A3	B3	C3	D3
CONTROLLING	A4	B4	C4	D4
COMMUNICATING	A5	B5	C5	D5

LESSONS
>LEARNED
>PROCEDURES
>POLICY
>LESSON SUMMARY

Figure 3. Performance Support Matrix

Performance Support provides factual information to supplement Job Entry lessons. This mechanism allows factual data to be easily updated and maintained without requiring modification to Job Entry lessons. "Mail" functions in Performance Support provide a mechanism for students to request assistance and for feedback regarding needed maintenance of Performance Support databases which will keep the information current. Performance Support files can also be accessed from the Job Entry modules. This provides an opportunity for the student to become familiar with this resource on-line, while engaged in the problem solving required in Modules II and III of Job Entry lessons.

Figure 4 demonstrates the relationship between the three levels of TPSS instruction, using the Critical Design Review (CDR) milestone as an example. The CDR is introduced at the Education level as one of the Reviews and Audits used by the Air Force to monitor contractor's performance. At the Job Entry level, a lesson presents the management responsibilities for a software engineer who will participate in a CDR. Finally, Performance Support offers continuous access to lessons learned, policies and procedures relevant to a CDR.

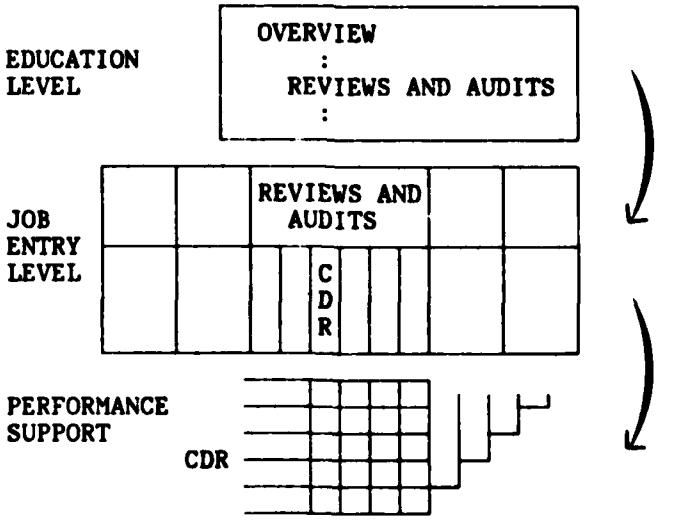

Figure 4. Curriculum Content

SECTION 4

PROTOTYPE SYSTEM DESCRIPTION

The TPSS prototype implements automated capabilities for developers, instructors, and students at the three levels of TPSS instruction. These computer-based capabilities provide tools for generating instructional materials, delivering CAI and Performance Support, and managing the instruction. These capabilities are used in the prototype for a specific curriculum, Software Acquisition Management. The functions, and the system which supports them, are not restricted to any subject area and can be used for instruction in other subject matter.

System Hardware

The prototype hardware configuration is shown in figure 5. The WICAT System 200 with 2 megabytes of main memory is the host minicomputer. There are 4 MG8000 graphics terminals for four Job Entry users. An 80 megabyte Winchester disk is used for storage, with a Cipher tape drive for back-up. An IDS Prism printer produces the hard-copy output.

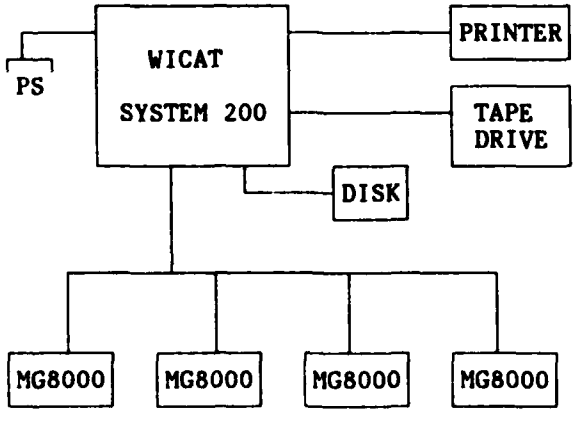

Figure 5. TPSS Prototype Hardware

Other installations of TPSS may require different hardware configurations depending on the application and required number of users. Each installation must have an external communications interface between the TPSS Performance Support and SPO terminals. At ESD this interface consists of a Device Driver which connects with eight Racal-Vadic modems. Communication is by phone lines from ASCII terminals in the SPOs. The operating system for the System 200 is WICAT's Multi-user Control System (MCS).

System Software

The software is largely comprised of two software packages developed by WICAT Systems of Orem, Utah: WISE, (WICAT Interactive System for Education), providing CAI functions, and SMART (System for Managing Authors, Resources, and Teachers), providing CMI functions. DRI developed and coded (PASCAL) the Performance Support, Design Editor and other integrating software.

WISE is a software package which helps authors create computer-based or video-based instruction without requiring computer programming skills. This software fulfills TPSS's requirements to create and deliver CAI lessons. Capabilities exist in WISE to accept and process an author's definition of the logic which controls branching, judging, and the text and graphic presentation of the material that make up a lesson. Branching is the computer's ability to transfer to another part of the lesson on the basis of a decision made either by the author or the student. Judging refers to the different sets of criteria used for assessing and scoring student input. Creation and manipulation of branching and judging within a lesson enables an author to define the organization of a lesson and the paths a student can take through it. Graphics and text editors are available to create displays interactively. These contain the tools for preparing questions, answers, menus, and animation sequences. During the process of development the author sees how the presentation will appear to the student. WISE actually supplies more options and techniques than were used in generating courseware for the prototype Software Acquisition Management curriculum.

WISE supports delivery of the instruction in several ways. It presents and controls access to instructional information in a central learning facility. Lesson files generated using the authoring capabilities are exercised by the student at one of the graphic terminals. The student is guided through the lesson by a sequence of actions which enable self-paced instruction.

SMART is a software package which provides computer-managed instruction functions. Users identified as system manager, developers, instructors, students, and resource managers each have specific capabilities. A developer's main function is the creating and structuring of courses using objectives and prescriptions. SMART provides a means for creating and editing objectives and defining a prescription to be associated with each objective. The prescription includes one or more lines of text entered by the developer and a list of the on-line lessons and system resources that are associated with the prescription. Lesson prerequisites and test results may be used in creating the prescription. Instructors can register students on the system, enroll the students in courses and assist in the management of the students. Students receive individualized prescriptions and can obtain reports on their progress against the defined objectives.

Performance Support software provides the capability to access hierarchically organized databases and a glossary from a remote work area. The database is accessible by a matrix which crosses management functions with types of information such as lesson summaries, policy and procedures, and lessons learned. An electronic mail function allows for an exchange of questions or comments from students or personnel in the SPOs, and responses from instructors and course developers. With the prototype, this data can be accessed from any ASCII terminal attached to a modem. Future configurations anticipate access over a bus network. New Performance Support databases can be created and existing ones modified using an editor.

A developer who is knowledgeable in a subject area and wishes to organize a curriculum for a subject area uses the Instructional Design Editor. This editor elicits information from the developer in a structured format and generates a hard-copy outline of a curriculum based on the responses. The outline helps the developer break down the subject area into achievable learning objectives, which can be supported by lessons, and identifies categories of information for the databases.

General purpose text processing tools are available for maintaining hard-copy materials such as lesson plans and workbooks.

The relationship of the instructional software components is illustrated in figure 6. Lessons files are exercised by students through the CAI capability. Lessons are organized into courses and

student enrollment is handled by the CMI. Performance Support processes requests and displays information retrieved from the databases. It is essentially independent but can be accessed through the CAI.

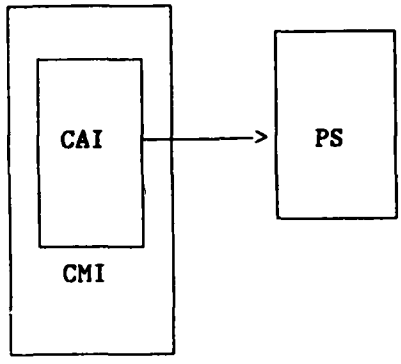

Figure 6. Instructional Software

The TPSS authoring process is illustrated in figure 7. The Instructional Design Editor (IDE) is used to prepare a structured outline of the course content. References are identified and the Performance Support Authoring process builds the text databases. To author a Job Entry lesson, a lesson script is prepared and entered using the menu-driven processing and text and graphic manipulations of the CAI authoring. The CAI software creates lesson files. The CMI software accepts and processes information on course organization and student prescriptions.

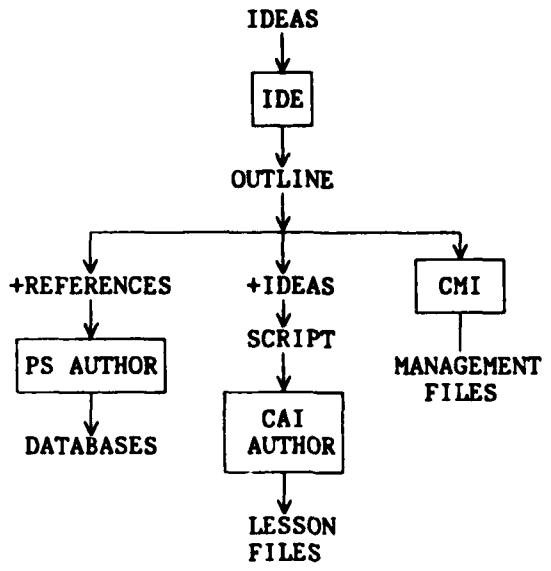

Figure 7. Authoring Software

User Interfaces

System capabilities and the interfaces between the system users are depicted in figure 8. Users are identified as developers (those who design and maintain a course), instructors, students, and SPO personnel who have completed Education and some Job Entry and have returned to the work environment.

One interface of the TPSS system is through an MG8000 graphics terminal where:

A developer enters ideas for a curriculum.
An author develops CAI lessons and Performance Support data.
An instructor enrolls students, responds to comments and requests from Performance Support users.
A student (the most frequent user) receives instruction for a particular job-related skill.

A second TPSS interface provides remote access from any ASCII terminal with communications capability (i.e., connected to a modem). There SPO personnel access Performance Support for databases of job-related information and a glossary. They can also send comments and requests to instructors through the Performance Support mailbox function.

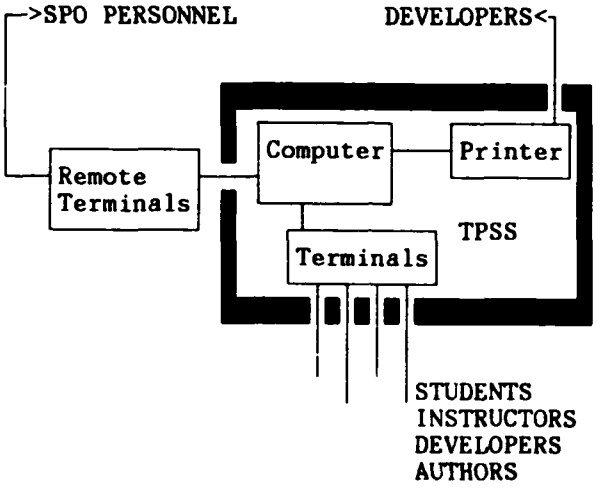

Figure 8. User/System Interfaces

SECTION 5

CONCLUSION

The prototype TPSS has demonstrated: (1) the ability to incorporate modern methods and techniques such as CAI and videotapes for training in an operational environment, (2) that instruction can be tailored to student needs through a modularized curriculum, and (3) that access to job support aids can be provided throughout a person's stay on the job. TPSS provides training in an effective and efficient manner by instructing students in what they need to know, when they need to know it from a centralized information source that is quickly and easily updated.

Benefits from TPSS have been identified in three areas.

First, TPSS provides better training in software acquisition management for entry level personnel. The TPSS courseware and computer-based instruction offer a current, standardized, and complete curriculum. This curriculum has been subjected to evaluation during the development process and its uniform content implies that the same terminology and procedures can be taught wherever the TPSS prototype curriculum is used. At the same time, provision is made for site specific requirements for courseware modifications. CAI lessons also provide refresher training for experienced or transferred personnel. The CAI is self-paced and adapts to the student's needs for flexible scheduling of lessons. Performance Support information will be more reliable as personnel verify and confirm standards and concepts being used in managing an acquisition. Information will be more current because volatile data will be controlled and updated.

The second benefit is increased productivity in the work environment. The system will impact on the software acquisition process, the environment in which that process takes place, and the military personnel actively involved in managing it. Information will translate into time saved in the work environment because correct, current information is retrieved by reference to the Performance Support database. As a result of TPSS training, CR personnel will be more efficient in managing software acquisition contracts. New personnel will perform useful work sooner and will assume more responsibilities because of an increased skill level.

The third benefit is realized improvements in the quality of systems being acquired under contracts managed by well-trained personnel. An objective of TPSS is to decrease the number and significance of less than optimal decisions made by managers of

acquisition programs. Fewer mistakes and delays on contracts managed by personnel who have access to TPSS, will increase the productivity of the acquisition. TPSS trained personnel will provide better management of the acquisition process and will increase the value the government receives on each contract. The net result is more defense readiness per dollar spent.

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